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13. ABSTRACT (Maximum 200 words) The curvature of the cervical spine in lateral view is discussed and a method based on digital statistical analysis is used to reproduce quantitative data of the curvature. Part I is a study based on the lateral view in the neutral position in 142 aviators. The radiograms are divided in 3 main groups: 1) Normal cervical lordosis. 2) Marked straightening of the cervical spine. 3) Segmental straightening with reversal of the curve. Part II discusses the use of the digital analysis to determine the displacement in subjects that have sustained ligamentous injuries of the cervical spine following whiplash injury.				
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## DATA ANALYSIS IN CERVICAL TRAUMA

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Summary:

The curvature of the cervical spine in lateral view is discussed and a method based on digital statistical analysis is used to reproduce quantitative data of the curvature. Part I is a study based on the lateral view in the neutral position in 142 aviators. The radiograms are divided in 3 main group: 1) Normal cervical lordosis. 2) Marked straightening of the cervical spine. 3) Segmental straightening with reversal of the curve. Part II discusses the use of the digital analysis to determine the displacement in subjects that have sustained ligamentous injuries of the cervical spine following whiplash injury.

The normal curvature of the cervical subdivision of the vertebral column is a smooth lordosis.

After trauma changes of curvatures are frequently seen, and straightening of the cervical spine is often assumed to be attributed to muscular tension following trauma to the neck. This seems to be a very common finding, however, a normal curvature usually returns as the symptoms subside. These quantitative measurements of change of curvature correlate well with clinical symptoms.

We have made an attempt at using a method based on digital statistical analysis in order to obtain reproducible quantitative data of the curvature found in the normal group of subjects.

Our results have been obtained by applying the digitalizing method to a material consisting of 142 aviators and a smaller group of subjects with documented injuries to the cervical spine.

The digitalized statistical analysis of the base line data

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The x-rays films that forms the basis for this study have been taken and supplied by the Radiology Department, Oslo Emergency Medical Center, Oslo City Hospital.

The study is reported in two parts:

Part I: A study of changes in the curvature of lateral X-rays of the cervical spine in neutral position is discussed.

Part II: The use of the digitalized method in patients that have sustained ligamentous injuries with instability following whiplash injuries is reported.

### Method

The method involves accurately plotting the outline of each vertebrae in the cervical spine and some bony prominencies, giving an outline of the spine. At the same time it has been possible to arrive at accurate measurements between bony structures. Due to enlargement, in spite of standard distances, subsequent X-rays will be comparable by using a correction coefficient so that fine adjustments can be made by using stable bony structures as land marks to allow for such changes.

The degree or depth of the cervical curvature is a function of the curve produced by the cervical bodies in a lateral view in a neutral position. Such measurements can be obtained by drawing a straight line from the superior posterior aspects of the odontoid process to the posterior inferior corner of the body of the seventh cervical vertebrae.

The line tracing the posterior vertebral bodies will usually produce a crescent shaped line corresponding to the curvature of the vertebrae.

The longest perpendicular between these two lines which usually falls in the vicinity of C4 will give a measurement of the depth of the cervical spine.

In a spine with marked straightening the measurement will be close to zero. In a normal curvature with retained lordosis this value will be positive, in most studies a mean value of 11,8 millimeters. In a spine with a reversal of the curvature a negative number has been reported.

### Part I

We have subjected the lateral cervical view in neutral position to digitalized analysis of 142 aviators. All subjects were fighter pilots with logged flying time from various fighter planes including the F-104, F-5 and F-16. We have in this study listed the findings to fit into the three main groups defined above.

We have no information of previous injury, and all aviators were fit for flying. We have assumed that osteochondrosis and degenerative changes are related to the age of the individual. Moreover, we have assumed that the age of the individual is related to the length of the flying time. As in most air forces some senior officers still maintain flying status in the RNoAF.

We have divided radiograms into three main groups:

- 1) Normal cervical lordosis
- 2) Marked straightening of the cervical spine
- 3) Segmental straightening with reversal of the curve of the cervical spine.

Out of the 142 aviators 63,3% had normal cervical lordosis. 26,8% showed straightening of the cervical spine, and 9,9% showed segmental straightening with reversal of the curve. The average age of for these three groups showed no significant difference - 26,4 - 26,8 - 26,1 years as average.

### Discussion

This is in accordance with other studies that supports the view that the documented changes are within normal limits and that these changes can not be used as a criterion suggesting pathological changes in the cervical spine.

### Part II

Flexion injuries are not uncommon in aviation medicine and has been recorded in acceleration of high intensity from positive to negative G. One of the authors of this presentation sustained such an injury in the passenger seat of a F-16 during a sudden and unexpected evasive manoeuvre.

In this second study we have examined individuals that have been subjected to whiplash injuries. It is assumed that the mechanism of the extension/flexion movement of the cervical spine in this injury is well known.

However, in modern cars the headrests are fixed with an upper border above the level of the external ear. This may to some extent reduce the extension movement and perhaps increase the momentum of the forward flexion of the neck at the time of injury.

It is expected that this trauma may produce injury to the posterior ligament complex including the supraspinous and interspinous ligament. Rupture of the posterior part of the interspinous disc with haemorrhage may occur and predispose to later degenerative changes.

When such injuries are suspected a functional study of the cervical spine should be made.

- a) The most consistent finding is that the space between the spinous processes at the level of injury is greater than the interspinous distances above and below the affected level.

- b) A horizontal displacement of the adjacent vertebrae in flexion.
- c) Marked limitation of movement of segments of the cervical spine is a finding suggesting injury.

Therefore, suggestion of segmental straightening of the cervical spine with reversal of the curvature may be indicative of such a lesion following injury, and a functional examination of the lateral view of the cervical spine should be undertaken.

There is, however, an interesting detail that involves the point of inflection between the two curves formed.

The point of inflection may coincide with the displacement of the apophyseal joints and may be explained in the following manner. Capsular ligaments of the apophyseal joints are dense fibrous structures, providing stabilization and limit the horizontal displacement of the adjacent vertebrae. Therefore, damage to the capsules allows forward displacement of the cranial facet surfaces, with loss of parallelism of the articular surfaces and widening of the joint spaces posteriorly.

These changes are demonstrated using the same digitized analysis method, demonstrating a displacement as indicated above.

### Discussion

The advantages of this method are accurate and objective measurements of the displacement of the cervical spine. Detailed objective measurements between subsequent X-rays studies may be obtained by adjusting for slight degrees of enlargement by compensating through fixed bony land marks.

What is perhaps even more important is the fact that these accurate measurements may prove extremely valuable in producing objective measurements of minute but gradual changes that occur in degenerative disorders of the spine. This will allow us to study consecutive series of films over a longer timespan and may provide us with an accurate measurement of the development of osteochondrosis in the cervical spine and how this may be affected by trauma or of change that occur due to the forces that the cervical spine is subjected to, for instance by high G forces.

Changes in the cervical spine may be recorded in relationship to time so that we may be able to evaluate the rate of development of osteochondrosis eit

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